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In the Matter of

Preparation for International Telecommunication Union World Radiocommunication Conferences	)))	IC Docket No. 94-31

COMMENTS OF MOBILE COMMUNICATIONS HOLDINGS, INC.

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COMMENTS TO THE SECOND NOTICE OF INQUIRY

SUMMARY

MCHI urges the Commission to adjust the allocation for MSS feeder links at 7 GHz to include the band 6725 - 7075 MHz, and, in concert with this adjustment, to allocate the 15.4 - 15.7 GHz band to NGSO Fixed Satellite Service feeder link uplink use and the 18.9 - 19.2 GHz band to NGSO Fixed Satellite Service feeder link downlink use, consistent with Table 2 of the Second Notice of Inquiry (January 31, 1995).

MCHI also urges the United States to appoint representatives to World Radio Conferences more in advance in order to increase the diplomatic posture of the United States and its likelihood of success at the WRC.

1. **The Commission should allocate the entire 6725 - 7075 MHz band to NGSO Fixed Satellite Service feeder link use in the downlink direction.**

a. **Some MSS systems, including Ellipso, require 300 MHz of downlink C-band spectrum**

MCHI has chosen to implement Ellipso using medium earth orbits (MEO) rather than low earth orbits (LEO), since the former confer, on balance, important operational and service advantages relative to the latter.

In the process of designing and implementing a technically and economically viable mobile satellite system, the designer is forced to make many compromises. One important design compromise that has attracted much attention is the choice between low and medium earth orbit altitudes. Of non-GSO MSS systems showing significant development, including Aries, Ellipso, Globalstar, Inmarsat-P, Iridium, and Odyssey, three (Aries, Globalstar, and Iridium) have chosen low earth orbits, and three have chosen medium earth orbits. The choice between low and medium earth orbit altitudes has a dramatic and well known impact (reduction) on the number of satellites required. It also has a real, but lesser known impact on the amount of feeder link spectrum required.

Satellites operating at MEO altitudes see significantly more of the earth's surface than satellites operating at LEO altitudes. For example, a satellite operating at Globalstar's operating altitude can view 26 million square kilometers of the earth's surface out to areas having an elevation angle to the satellite of 10 degrees. In contrast, satellites operating at Ellipso's altitude at apogee (or in the equatorial orbit, at *all* times), can view 105 million square kilometers out to areas having the same elevation angle. Because the MEO satellites are higher, they view a much larger area of the earth with relatively high elevation angles, and there is generally more overlap among satellite service areas.

Higher elevation angles significantly reduce the incidence of shadowing and multipath, improving the performance of the satellite link to and from the user. Less margin for shadowing is necessary, and the satellite becomes more efficient in its power requirements per user.[1] Since in serving mobile users the system has no control over the path from the satellite to the user, maintaining path geometries that minimize the likelihood of impairments is essential for high quality service. Failing high elevation angles (as with many LEO systems), the system design must allocate more margin for combating a higher incidence of shadowing, rendering the system less power efficient.

Figure 1 illustrates the advantages that higher operating altitudes yield in minimum elevation angles for four of the six cited MSS systems. It is readily apparent that those systems shown that operate at medium earth orbit altitudes (Ellipso and Odyssey) provide significantly better minimum elevation angles to the user than those system operating at low earth orbit altitudes (Globalstar and Iridium). This is true despite the fact that the MEO systems deploy from one-third to less than one-fifth the number of satellites deployed by the LEO systems.

[1]Note that a target service area seen from a satellites operating at higher altitudes subtends a smaller solid angle than the same area seen from a lower satellite. An antenna designed to serve that area from the higher altitude with have higher gain, since it must form a beam with the smaller solid angle. This higher antenna gain compensates for the increase in range to the earth from the satellite. As a consequence, there is effectively no requirement to increase the power required to serve a service area with increasing altitude.

Satellites operating at higher altitudes also require fewer ground stations than LEO satellites, and can operate to mobile terminals having greater offsets from the ground entry station without requiring satellite crosslinks.

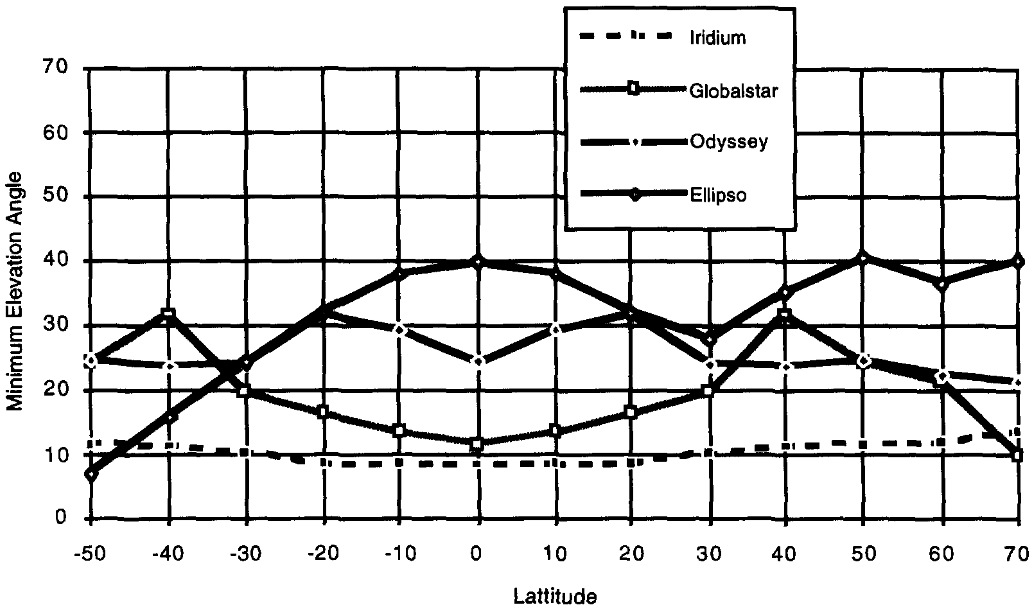

Figure 1

Minimum Elevation Angles for Selected Mobile Satellite Systems

Despite the fact that MEO MSS satellites are typically larger and cost more to launch than LEO MSS satellite, it is MCHI's finding that the above-cited factors (aided, in Ellipso's case, by the choice of lower-energy elliptical orbits) render the MEO designs, in general, more economic in system cost and cost to the user than LEO designs, all else being equal. Significantly, two other MSS developers came to the same conclusion, TRW and Inmarsat. MCHI believes that the MSS user community will benefit from the superior service a MEO design offers.

However, since the MEO satellites view greater area on the earth, and since similar performance among systems requires similar ground areas per beam (in order to yield similar numbers of effective "cells" over the service area), a MEO satellite must create and serve more beams than LEO satellites, all else being equal. These beams must be mapped to channels on the feeder links. A larger number of beams increases the MEO satellite's requirement for feeder link spectrum to support the beams, in compensation for the deployment of fewer satellites.

MCHI notes that both Odyssey and Ellipso have requested 300 MHz of feeder link to serve their larger number of user beams, in contrast to the 200 MHz requested by Globalstar and Constellation[2]. It is quite likely that other entrants into MSS might seek as much as 300 MHz of feeder link spectrum, particularly in light of the ever increasing number of user beams per satellite declared by entrants into the MSS field.

Note finally that Ellipso can share its feeder link spectrum with another one (or indeed two) mobile satellite systems. Loral and Comsat have indicated they can do the same.

b. MSS expansion will increase feeder link spectrum requirements

For a given user terminal design (for handhelds, constrained to less than a watt of power and near 0 dBi antenna gain by safety and practicality respectively), capacity is proportional to the number of beams subdividing a service area and to the PFD permitted. PFD is limited by international rules.

[2]Iridium and Inmarsat-P cannot be directly compared to CDMA systems, since Iridium uses on-board processing and crosslinks, and since they both use TDMA and therefore can use on average only a subset of L band spectrum in each beam. However note that the MEO TDMA Inmarsat uses at least four times more user beams than the LEO TDMA Iridium per satellite.

Consequently, the primary mechanism for adding capacity will be by subdividing service areas into a greater number of user beams in order to achieve greater frequency reuse. The same approach to adding capacity can be seen applied today in cellular networks.

But as upgraded MSS satellites add more, smaller beams to meet MSS market growth, the requirement for feeder link bandwidth per system will also grow. There is already widespread opinion that the market for MSS services will quickly outstrip the capacity available from present systems. For example, Hughes plans to launch an ambitious GEO satellite with 50 foot diameter antennas to close the links with handheld telephones.[3] This satellite is planned to have 16,000 channels, which far exceeds the capacity of the NGSO MSS systems in a region. Futhermore, an overlay system where a GSO satellite auguments the NGSO MSS to increase capacity in a region would be another expansion approach. It can be expected that every MSS system will seek to expand global capacity, and that requirements for NGSO MSS feeder link spectrum will expand comensurately. Feeder link spectrum allocations should minimize any requirement for systems to change feeder link bands incidental to growth.

c. **The Commission should allocate at least 300 MHz of spectrum to NGSO MSS feeder links at 7 MHz.**

For all the above reasons, MCHI strongly urges the Commission to increase its proposed 7 GHz NGSO feeder link allocation to include 6725 to 7075 GHz, rather than subdividing the existing FSS band to create a smaller NGSO feeder link band. There is presently adequate spectrum at 7 GHz to

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[3] Smith, Bruce A. "HS 601 to Link Handheld Phones" *Aviation Week and Space Technology*, January 30, 1995. Pages 28-29.

allocate at least 300 MHz to NGSO MSS feeder links. Working groups at the ITU have identified at least 300 MHz at 7 GHz as a candidate for NGSO MSS use. Obtaining adequate spectrum now will avoid a requirement to seek additional spectrum in the band a second time, later.

There seems little reason to limit an NGSO MSS feeder link allocation at this frequency to any less, other than arbitrarily to match the proposed allocation at 5 GHz, where a maximum of only 250 MHz is available. However, constraining the allocation at 7 GHz to that at 5 GHz seems to be unwise for two reasons. First, the proposed allocation at 5 GHz to NGOS MSS feeder links is significantly weakened by the priority given the Microwave Landing System (MLS) in a large portion of this band (potenially up to 120 MHz, as noted in the Second Notice of Inquiry) and by the large separation distances required by the FAA to ensure protection to MLS. This priority to MLS encourages NGSO MSS systems to seek other spectrum for feeder links. Second, the 7 GHz band can be paired with other spectrum having greater bandwidth than the 250 MHz available at 5 GHz.

A 300 - 350 MHz allocation will grant MEO systems like Ellipso a C band downlink alternative. It will also enable C band systems that must increase capacity to meet additional demand, fundamentally by creating more, smaller beams, to continue to use this band after such an increase.

MCHI urges the Commission to support allocation of the band 6725 - 7075 to NGSO MSS feeder link downlink use.

2. **The Commission should allocate the 15.4 - 15.7 GHz band to NGSO Fixed Satellite Service feeder links in the uplink direction, consistent with Table 2 of the Second Notice of Inquiry.**

MCHI notes that there is a contradiction between Table 2 on page 27 and Appendix 1, pages 11 and 12 of the Second Notice of Inquiry in specifying the feeder link direction for the 15.4 - 15.7 GHz ("15 GHz band") and 18.9 - 19.2 GHz ("19 GHz band") bands. Table 2 states the 15 GHz band is to be used in the uplink direction and the 19 GHz band is to be used in the downlink direction, while Appendix 1, pages 11 and 12, states the 15 GHz band is to be used in the downlink direction and the 19 GHz band is to be used in the uplink direction. MCHI assumes that Table 2 is correct, since Table 2 is consistent with the recommendation of the Industry Advisory Committee and with the MSS requests for that spectrum in the November 1994 amended filings. Appendix 2 is consistent with neither.

In any case, MCHI urges the Commission to adopt the NGSO MSS feeder link directions-of-use specified in Table 2 for the 15 and 19 GHz bands. Adopting the directions shown in Table 2 would continue to permit pairing the 15 and 19 GHz bands while also permitting pairing the 15 GHz band with the 7 GHZ NGSO MSS downlink band, a band suitable for systems using low gain satellite feeder link antennas. Such a pairing would grant important C band feeder link operating capability to MSS systems requiring C band, but also requiring more bandwidth than otherwise available in the 5 GHz C band uplink band. Using the 15 and 19 GHz bands in the manner suggested by Appendix 1 would preclude this additional pairing.

To reiterate earlier comments to the Commission[4], MSS systems using economical transponding satellites and distributed ground network architectures require earth coverage or near earth coverage feeder link antennas. This limits feeder link antenna gain and therefore overall eirp and G/T available at the satellite for feeder links. Since high eirp and G/T are necessary to combat excess atmospheric attenuation, as from rain (additional RF power on the satellite to compensate for low antenna gains being very difficult to achieve), MSS systems that must use low gain feeder link antennas are constrained to use feeder link frequencies having low excess attenuation, as in C band. Furthermore, the generation of the relatively high RF power required for feeding earth coverage feeder link antennas is significantly easier at C band on-board the satellite than at Ku or Ka band. Suitable low voltage solid state devices are available at C-band, but only high voltage tubes at Ku or above.

In addition, MCHI seeks to operate its TT&C links in the Ellipso feeder link bands, if possible, (as do other systems) and avoid having to use a separate band and additional components for TT&C. However TT&C links require a capability to operate from and to omnidirectional antennas on the satellite, in case the satellite loses proper orientation. Using omni-directional satellite antennas, TT&C transmitters on the satellite have very low eirp. TT&C links must therefore minimize path and atmospheric losses in order to assure effective satellite monitoring and control. For this reason, C band (or S band) is typically favored for such TT&C applications. If the feeder links must

[4]See for example: "Presentation of Loral Qualcomm Satellite Services, Inc. to Common Carrier Bureau Federal Communications Commission". February 28, 1994; also letter from Mobile Communications Holdings, Inc. to Mr. William F. Caton, Acting Secretary, Federal Communications Commission, re: Ex Parte Presentation, CC Docket No. 92-166; IC Docket No. 94-31, 14 September, 1994

operate in Ku or Ka band, systems like Ellipso will require separate C or S band TT&C links and additional associated C or S band equipment on board the satellite, rather than including TT&C in the feeder link allocation[5].

For all these reasons, all MSS systems using transponding payloads and earth coverage feeder links , including Ellipso, have requested C-band feeder link spectrum.

But MCHI recognized that there is little likelihood of finding both uplink and downlink C-band spectrum offering sufficient bandwidth (300 MHz) for Ellipso or similar systems. For this reason, MCHI has requested 300 MHz in the 7 GHz band for Ellipso downlinks and the (hitherto) non-directional 15 GHz band for its uplinks in its amended filing of November, 1994.

As discussed above, designating the 15 GHz band as an uplink band for NGOS MSS will permit additional paired 15/7 GHz paired operation, and enable MSS systems to realize the significant efficiencies and operating advantages possible with such a pairing. MCHI therefore urges the Commission to allocate the 15 GHz band to uplink use and the 19 GHz band to downlink use, as illustrated in Table 2 of the Second Notice of Inquiry (January 31, 1995).

3. Comments on the Conference Preparatory Processes

The concerns and ideas summarized in paras. 104-108 are directed toward in some way institutionalizing the private sector's participation in policy making for future WRC's. To that end, a number of proposals have

[5]note that since high power at Ku band is much easier to generate on the ground than on the satellite, Ellipso can accept Ku band TT&C uplinks.

been but forward, including establishing a permanent IAC, creating a WRC Preparatory Office in the FCC and encouraging more regular participation by other government agencies. All of these ideas and others have merit insofar as they assure a permanent preparatory process assisted by the private sector. Surely this is a logical response to the very far-reaching changes proposed by the ITU's High Level Committee and adopted by the ITU.

What seems missing from these suggestions is a technique for factoring in the views of other governments and of the private sector in other countries. The success of the US at WARC '92 was in part the result of a very vigorous diplomatic campaign, initiated early-on and involving participation by the private sector. While tactics may vary from one WRC to the next, because issues and interests vary, exposure of the private sector to the constraints and opportunities inherent in the global scope of the issues should result in better, more realistic and realizable proposals.

There are certainly a variety of ways of achieving this objective. Two worth considering are:

--The early designation of the US Delegation, or at least its senior members. They could then participate in the work of the IAC and its subcommittees and thus get an authoritative sense of the views of the private sector.

-- The early designation of the head of the US delegation. The continuing tendency to appoint the US delegation chair late in the process hurts not only the chair's learning process, but the chair's authority and ability to sell the US position abroad. One possible approach would be to appoint a delegation head for at least a two year term, covering at least two WRC's. This would help assure continuity and leadership in the internal US coordination process and authority internationally. There are few things more debilitating to the US position internationally than the sure knowledge on the part of other countries that once a WRC (or Plenipotentiary conference) has ended, they will never have to deal with the US Chair again.

Respectively submitted,

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